Conceptual Design of Isotope Separator On-Line Target for Rare Isotope Accelerator

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ABSTRACT

Isotope Separator On-Line (ISOL) is one of the two types of targets that are being conceptually designed for the Rare Isotope Accelerator (RIA); a 400 kW accelerator for ions from hydrogen to uranium, with the goal of providing a better understanding of exotic nuclei. The ISOL target is composed of a main target, the tungsten core and a secondary target of 133 uranium carbide disks that surrounds the tungsten. Three essential design objectives of the ISOL target were evaluated, (1) cooling the target during beam operation, (2) analyzing the beam window, and (3) ease of replacement with remote handling equipment. The secondary target is thermally cooled by water flowing through two sets of pipes that spiral around the uranium carbide disks. The tungsten is directly cooled by water flowing through small spiraling channels in the tungsten. This is achieved by encasing the tungsten inside a pipe to force the water through the channels at 300 psi. The ion beam goes through the pipe to contact the tungsten making the pipe the target beam window. To ensure that the pipe can manage both the internal pressure of the water and the thermal gradient created by the beam passing through it, Mechanica, a finite element analysis program, was implemented to calculate the theoretical stresses the pipe will experience. By analyzing a range of wall thickness from 0.5 to 1.5 millimeters with two materials, stainless steel and aluminum, it was discovered that aluminum at 1.5 mm allows the greatest factor of safety. The ISOL target needs to be replaced frequently because of the high level of energy the tungsten receives, making the target radioactive to the point it must be handled completely remotely. To make the process simple the target only has four Hiltap water connections. The electrical power connects automatically when the target is placed in the base of the target module. Handles, hook plates, and alignment pins are also added to guide the target in and out of the target module to make replacement less difficult. The ISOL target is a continually changing design as new ideas are modeled and analyzed. With every small change or addition the ISOL conceptual target becomes a little closer to becoming a reality.

VITA

Adam J. Carroll is a Mechanical Engineering Junior at the University of Arizona. He looks forward to graduate school at a yet to be determined location.